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(54) Method for monitoring solder paste printing process

(57) The invention relates to a method for monitoring the paste printing process in the setting and soldering of a circuit board. In the paste printing process, solder paste (5) is spread on the circuit board (4) at the surface mounted devices to be set or at the corresponding solder pads (7) of the connecting pins. According to the invention, at least one paste test pattern (9) is arranged on the circuit board (4), which test pattern consists of a number of test elements (91, 92, 93, 94), shaped like geometrical plane figures on the surface of the circuit board, and which test elements have varying degrees of difficulty in view of the printing process.

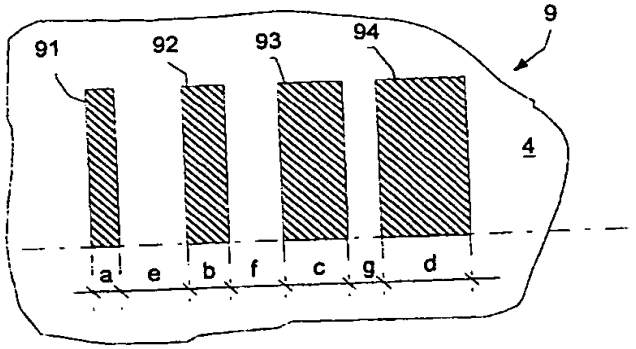

FIG. 3

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In the following, the invention will be described in more detail with reference to the appended drawings, in which

Figure 1 shows a cross-section of the solder paste printing process;

Figure 2 shows an enlarged cross-section of the solder pad on which the paste deposit has been applied in the paste printing process;

Figure 3 shows one advantageous test pattern for estimating the quality of the paste printing process;

Figure 4 shows another advantageous test pattern for estimating the quality of the paste printing process;

Figure 5 shows a circuit board panel which comprises many circuit boards, in which circuit board billet a test pattern has been applied; and

Figure 6 shows a diagrammatic plan of automatic monitoring equipment for the paste printing process.

In this invention report, setting and soldering of the circuit board means the arrangement and fastening of components, which transmit and/or process electricity and/or electric signals, on the circuit board, which itself contains the wiring between the components and possibly also connections to peripheral devices.

The electronic components used today, the VLSI circuits in particular, are most often surface mounted devices (SMD).

These components are set on the surface of the circuit board. The circuit board contains the wiring which connects various components and other electric devices, such as connectors. In order to attach the surface mounted devices on the surface of the circuit board, a paste-like solder alloy is printed at the solder pads which correspond to the connecting pins. Paste deposits of a suitable size are thus formed at the solder pads. After this, the surface mounted devices are set on the circuit board. The components stay where they are put on the circuit board, because they stick to the paste deposits of the solder pads at their connecting pins. After the setting, the circuit boards are arranged to go through a hot furnace, where the paste melts and the components are fastened in place at the connecting pins. When the circuit board cools down, the paste hardens and the solder joint at the solder pad of each connecting pin is complete.

The principle of the surface mounting process is illustrated in the Figures 1 and 2. A printing mask or stencil 1, which is a thin metal plate, for example, is used in the surface mounting process. Openings 2 have been etched on the stencil 1 at the solder pads 7 reserved for the connecting pins of the surface mounted devices. The stencil 1 is fastened to a frame 3. In the solder paste printing process, the stencil 1 fastened to the frame 3 is placed on the surface of the circuit board 4 or in close vicinity to it at a precisely specified point so that the openings 2 match the solder pads 7. Solder paste 5 is applied on the upper surface of the stencil 1. The paste 5 is spread with a special spatula 6 over the circuit board 4 so that the paste fills the openings 2 of the stencil 1 and is squeezed onto the surface of the circuit board 4 at the predetermined solder pads 7. When the stencil 1 is lifted off from the circuit board 4, the paste remains as deposits 8 of suitable height h on the surface of the circuit board 4 at the openings 2 and solder pads 7.

The solder pads 2 of the surface mounted device on the circuit board 4 are generally rectangular areas, the size of which corresponds to the size and shape of the connecting surface of the connecting pins of the component. The solder pads 7 are arranged at distances which correspond to the distance of the connecting pins of the components and in a shape that corresponds to the shape formed by the connecting pins of the component.

The coverage area of the paste deposit 8 depends on the width and length of each opening 2 of the stencil 1. In addition, the height of the paste deposits 8 depends on the thickness of the stencil 1 (height h of paste deposit, see e.g. Figure 2). The size of the openings made in the stencil 1 is determined by the size of the solder pad spots in the photographic film used in the manufacture of the stencil. The solder pad spots are usually a little smaller than the solder pads, but when the openings 2 are etched in the stencil 1, they are generally slightly overetched and thus they become the size of the solder pads 7. If it seems that the amount of paste applied on the solder pad 7 with the stencil 1 is not appropriate, the solder pad spots of the photographic film can be decreased or increased according to need, and a new stencil 1 with openings 2 of the right size can be made.

The purpose of the solder paste printing process is to achieve a right-sized paste deposit 8 on the solder pads 7, or a sufficient amount of paste; not too much and not too little, so that the connecting pins can be fastened by a solder joint reliably on the solder pads 7 reserved for them and related to the wiring. The method of the invention is used particularly for verifying the right size of the paste deposits.

When the Figure 3 is examined, it can be seen that a paste test pattern 9, separate from the actual solder pads 7 of the components, has been applied on the circuit board 4, which test pattern 9 comprises a number of geometrical test elements 91, 92, 93, 94. These test elements are of varying degree of difficulty in printing.

The test pattern 9 in Figure 3 consists of four rectangular test elements 91, 92, 93, 94, which are of different widths, denoted by a, b, c and d, respectively. In addition, the test elements 91, 92, 93, 94 are arranged in a straight line in sequence at different distances from each other in a manner such that the distance between the test elements 91, 92 is e, the distance between 92

ing manner, for example. The circuit boards 27, which have passed through the paste printing process, are arranged to go through the observation field and exposure area of the camera 21 on a suitable conveyer in a manner such that the test pattern 28 can be photographed by the camera. The processing unit 25 compares the test patterns 28 of the circuit board 27 photographed by the camera 21 to the shapes of test patterns saved in the memory unit 24 by means of the application programs, and observes the differences on the basis of which the quality of the paste printing process is evaluated in accordance with agreed criteria, such as the criteria described above.

In the Figures 3 and 4 above, various test patterns 9; 10, 11, have been presented by way of example. It is to be noted, however, that the test patterns can differ from those presented. The test pattern can consist of test elements with different basic geometrical shapes, such as rectangle, square, circle etc. These test elements can be arranged at different distances from each other. The test elements of a test pattern can contain parts of mutually different width. In general, it can be said that the paste test pattern consists of geometrical plane figures, which can vary and have gaps of different width between them, so that different parts of the test pattern have different degrees of difficulty in view of paste printing.

Claims

1. A method for monitoring the solder paste printing process in the setting and soldering of a circuit board, in which paste printing process solder paste (5) is spread on a circuit board (4) at the solder pads (7) of surface mounted devices or corresponding connecting pins, **characterized** in that for evaluating the quality of the paste printing process at least one paste test pattern (9; 10; 18) is arranged on the circuit board (4; 13), which test pattern is constituted by a number of test elements (91, 92, 93, 94; 111, 112, 113, 114; 121, 122, 123, 124), the shapes of which correspond to geometrical plane figures on the surface of the circuit board, which test elements have varying degrees of difficulty in view of the printing process.

2. A method according to Claim 1, **characterized** in that the test pattern is constituted by test elements of different shapes, corresponding to geometrical plane figures.

3. A method according to Claim 1, **characterized** in that the test elements (91, 92, 93, 94) of the test pattern (9) are arranged at different distances (e, f, g) from each other.

4. A method according to Claim 1, **characterized** in that the test elements (91, 92, 93, 94) contain parts of mutually different widths (a, b, c, d).

5. A method according to Claim 1, **characterized** in that the test pattern (9) is constituted by test elements (91, 92, 93, 94), essentially rectangular in shape, which have different widths (a, b, c, d).

6. A method according to Claim 5, **characterized** in that the test pattern (9) is constituted by four test elements (91, 92, 93, 94), which have been arranged at different distances (e, f, g) from each other.

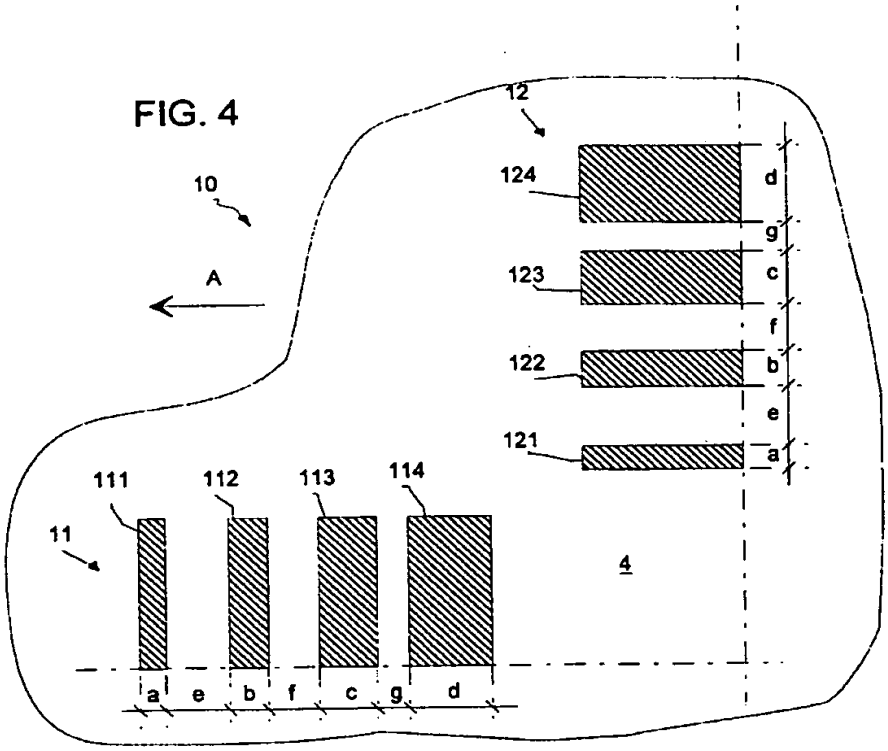
7. A method according to Claim 5 or 6, **characterized** in that the test pattern (10) consists of two sets of test elements (11, 12), each of which consists of a number of test elements (111, 112, 113, 114; 121, 122, 123, 124), which have been arranged at different distances from each other and which sets are at an angle, preferably a 90° angle, in relation to each other.

8. A method according to any one of the preceding claims, **characterized** in that the test pattern (18) is arranged on the circuit board billet (13), which comprises several circuit boards (14, 15, 16, 17).

9. A method according to any one of the preceding claims, **characterized** in that the paste printing process is monitored on the basis of the test pattern (28) automatically by means of monitoring equipment (20).

10. A method according to Claim 9, **characterized** in that the monitoring is implemented by means of monitoring equipment (20) constituted by a camera (21) and a monitoring unit (23) connected to it, which monitoring unit consists of a memory unit (24), to which the shape of the test pattern (28) has been saved, and a processing unit (25), in which processing unit (25) the test patterns (28) photographed with the camera (21) are compared to the saved shapes of test patterns and the differences are observed, on the basis of which differences the quality of the paste printing process is evaluated.

FIG. 4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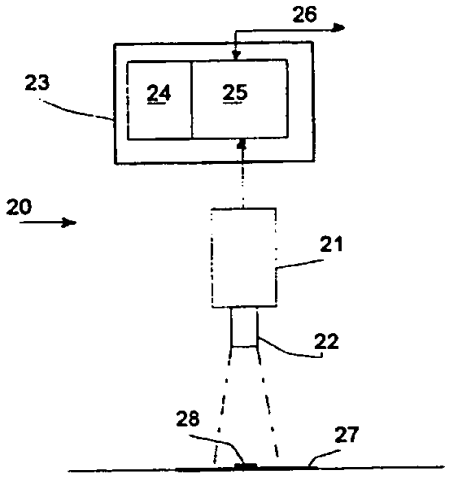
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FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 96 66 0090

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	PATENT ABSTRACTS OF JAPAN vol. 16, no. 31 (E-1159), 27 January 1992 & JP 03 244188 A (FUJITSU), 30 October 1991, * abstract *	1-8	H05K3/34
Y		9,10	
Y	PATENT ABSTRACTS OF JAPAN vol. 17, no. 76 (P-1487), 16 February 1993 & JP 04 279808 A (SHARP CORP), 5 October 1992, * abstract *	9,10	
X	PATENT ABSTRACTS OF JAPAN vol. 15, no. 199 (M-1115), 22 May 1991 & JP 03 052761 A (MATSUSHITA ELECTRIC IND CO), 6 March 1991, * abstract *	1,3	
A	PATENT ABSTRACTS OF JAPAN vol. 17, no. 615 (E-1459), 12 November 1993 & JP 05 191034 A (SHARP CORP), 30 July 1993, * abstract *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6) H05K
A	PATENT ABSTRACTS OF JAPAN vol. 17, no. 639 (M-1515), 26 November 1993 & JP 05 200991 A (MATSUSHITA ELECTRIC IND CO), 10 August 1993, * abstract *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 March 1997	Mes, L

CATEGORY OF CITED DOCUMENTS

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